

What is claimed is:

1. A method for forming a storage node of a capacitor, comprising the steps of:

5 forming a first amorphous silicon layer doped with an impurity in a predetermined first doping concentration suppressing dopants from locally agglomerating;

forming an impurity undoped second amorphous silicon layer on the first amorphous silicon layer in an in-situ  
10 condition;

forming a storage node by patterning the first amorphous silicon layer and the second amorphous silicon layer;

forming silicon grains on a surface of the storage node; and

15 doping the impurity to the storage node and the silicon grains until reaching a second predetermined concentration for providing conductivity required by the storage node.

2. The method as recited in claim 1, wherein the first  
20 impurity doping concentration ranges from about  $1 \times 10^{19}/\text{cm}^3$  to about  $2 \times 10^{20}/\text{cm}^3$  and the second impurity doping concentration ranges from about  $24 \times 10^{20}/\text{cm}^3$  to about  $1 \times 10^{22}/\text{cm}^3$ .

3. The method as recited in claim 1, wherein the step of  
25 doping the impurity onto the storage node and the silicon grains proceeds by performing one doping method of a chamber

plasma doping in an atmosphere of a gas containing phosphorus.

4. The method as recited in claim 3, wherein the chamber plasma doping is performed at a temperature ranging from about  
5 700 °C to about 800 °C and a pressure ranging from about 1.5 torr to about 2.5 torr for about 2 minutes and about 5 minutes by supplying a plasma power ranging from about 300 W to about 500 W and phosphine ( $\text{PH}_3$ ) flowed with a quantity of about 300 sccm to about 500 sccm.

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5. The method as recited in claim 1, wherein the step of doping the impurity onto the storage node and the silicon grains proceeds by performing another doping method of a furnace annealing in an atmosphere of a gas containing  
15 phosphorus.

6. The method as recited in claim 5, wherein the furnace annealing is performed at a temperature in a range from about 600 °C to about 750 °C and a pressure ranging from  
20 about 5 torr to about 10 torr for about 1 hour to about 2 hours by flowing  $\text{PH}_3$  gas with a quantity ranging from about 100 sccm to about 200 sccm.

7. The method as recited in claim 1, wherein the step  
25 of doping the impurity onto the storage node and the silicon grains further includes the steps of:

performing a chamber plasma doping in an atmosphere of a gas containing phosphorus; and

diffusing the doped impurity through a furnace annealing.

5           8. The method as recited in claim 7, wherein the chamber plasma doping is performed at a temperature ranging from about 700 °C to about 800 °C and a pressure ranging from about 1.5 torr to about 2.5 torr for about 1 minute and about 5 minutes by supplying a plasma power in a range from about  
10 300 W to about 500 W and PH<sub>3</sub> gas flowed with a quantity ranging from about 100 sccm to about 500 sccm.

          9. The method as recited in claim 7, wherein the furnace annealing is performed at a temperature ranging from  
15 about 600 °C to about 750 °C and a pressure ranging from about 5 torr to about 10 torr in an atmosphere of nitrogen for about 1 hour to about 2 hours.

          10. The method as recited in claim 1, wherein the step  
20 of forming the silicon grains on the surface of the storage node further includes the step of cleaning the surface of the storage node on which the silicon grains are formed.

          11. The method as recited in claim 10, wherein the step  
25 of cleaning the surface of the storage node proceeds by using a wet chemical such as hydrogen fluoride (HF) and buffered

oxide etchant (BOE).

12. A method for fabricating a capacitor of a semiconductor device, comprising the steps of:

5 forming an insulation layer having contact holes on an upper surface of a substrate;

forming a plurality of plugs connected to the substrate by being filled into the contact holes;

10 forming an isolation layer having holes exposing the plurality of the plugs on the insulation layer;

forming a first amorphous silicon layer doped with an impurity in a predetermined first doping concentration suppressing dopants from locally agglomerating;

15 forming an impurity undoped second amorphous silicon layer on the first amorphous silicon layer in an in-situ condition;

forming a storage node by patterning the first amorphous silicon layer and the second amorphous silicon layer;

20 forming silicon grains on a surface of the storage node; and

doping the impurity to the storage node and the silicon grains until reaching a second predetermined concentration for providing conductivity required by the storage node.

25 13. The method as recited in claim 12, after the step of doping the impurity onto the storage node and the silicon

grains, further comprising the steps of:

removing selectively the isolation layer;

doping additionally the impurity to compensate a doping profile of the storage node; and

5 forming sequentially a dielectric layer and a plate on the storage node.

14. The method as recited in claim 12, after the step of doping the impurity onto the storage node and the silicon  
10 grains, further comprising the step of forming sequentially a dielectric layer and a plate on the storage node and the isolation layer.

15. The method as recited in claim 13, wherein the step  
15 of doping additionally the impurity to compensate the doping profile of the storage node proceeds by performing one doping method of a chamber plasma doping in an atmosphere of a gas containing phosphorus.

20 16. The method as recited in claim 15, wherein the chamber plasma doping is performed at a temperature ranging from about 700 °C to about 800 °C and a pressure ranging from about 1.5 torr to about 2.5 torr for about 2 minutes to about 5 minutes by supplying a plasma power ranging from about 300 W  
25 to about 500 W and  $\text{PH}_3$  gas with a flow quantity ranging from about 300 sccm to about 500 sccm.

17. The method as recited in claim 13, wherein the step of doping additionally the impurity to compensate the doping profile of the storage node proceeds by performing another doping method of a furnace annealing in an atmosphere of a gas  
5 containing phosphorus.

18. The method as recited in claim 17, wherein the furnace annealing is performed at a temperature ranging from about 600 °C to about 750 °C and a pressure ranging from about  
10 5 torr to about 10 torr for about 1 hour to about 2 hours by flowing PH<sub>3</sub> gas with a quantity in a range from about 100 sccm to about 200 sccm.

19. The method as recited in claim 12, wherein the first  
15 doping concentration ranges from about  $1 \times 10^{19}/\text{cm}^3$  to about  $2 \times 10^{20}/\text{cm}^3$  and the second doping concentration ranges from about  $24 \times 10^{20}/\text{cm}^3$  to about  $1 \times 10^{22}/\text{cm}^3$ .

20. The method as recited in claim 12, wherein the step  
20 of doping the impurity on the storage node and the silicon grains proceeds by performing one method of a chamber plasma doping in an atmosphere of a gas containing phosphorus.

21. The method as recited in claim 20, wherein the  
25 chamber plasma doping is performed at a temperature ranging from about 700 °C to about 800 °C and a pressure ranging from

about 1.5 torr to about 2.5 torr for about 2 minutes to about 5 minutes by supplying a plasma power in a range from about 300 W to about 500 W and PH<sub>3</sub> gas with a flow quantity ranging from about 300 sccm to about 500 sccm.

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22. The method as recited in claim 12, wherein the step of doping the impurity on the storage node and the silicon grains proceeds by performing another method of a furnace annealing in an atmosphere of a gas containing phosphorus.

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23. The method as recited in claim 22, wherein the furnace annealing is performed at a temperature ranging from about 600 °C to about 750 °C and a pressure ranging from about 5 torr to about 10 torr for about 1 hour to about 2 hours by flowing PH<sub>3</sub> gas with a quantity in a range from about 100 sccm to about 200 sccm.

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24. The method as recited in claim 12, wherein the step of doping the impurity onto the storage node and the silicon grains includes the steps of:

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performing a chamber plasma doping in an atmosphere of a gas containing phosphorus; and

diffusing the doped impurity through a furnace annealing.

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25. The method as recited in claim 24, wherein the chamber plasma doping is performed at a temperature ranging

from about 700 °C to about 800 °C and a pressure ranging from about 1.5 torr to about 2.5 torr for about 1 minute to about 5 minutes by supplying a plasma power in a range from about 300 W to about 500 W and PH<sub>3</sub> gas with a flow quantity ranging from  
5 about 300 sccm to about 500 sccm.

26. The method as recited in claim 24, wherein the furnace annealing is performed at a temperature ranging from about 600 °C to about 750 °C and a pressure ranging from about  
10 5 torr to about 10 torr in an atmosphere of nitrogen for about 1 hour to about 2 hours.

27. The method as recited in claim 12, wherein the step of forming the silicon grains on the surface of the storage  
15 node further includes the step of cleaning the surface of the storage node on which the silicon grains are formed.

28. The method as recited in claim 27, wherein the step of cleaning the surface of the storage node proceeds by using  
20 a wet chemical such as HF or BOE.